Research Note: Context-Selected Linear Operators for Large Symbolic Sequence Spaces

Many biological and symbolic systems operate over sequence spaces of extraordinary combinatorial complexity. Examples include genomic sequences, regulatory motifs, and other long symbolic strings.

A natural assumption is that such systems require equally complex computational models. However, an alternative possibility is worth considering.

Instead of associating each symbolic context with an arbitrary computation, each context could select a member of a restricted family of **local linear operators**. The combinatorial complexity would then reside primarily in **context selection**, while the local computation would remain within a low-complexity operator space.

This perspective separates two distinct quantities:

- **Context complexity** — the number of possible symbolic states.
- **Operator complexity** — the complexity of the computation associated with each state.

Although the first may be enormous, the second can remain tightly constrained. Such a restriction introduces a strong inductive bias and may improve statistical efficiency by forcing each context to learn a simple local approximation rather than an arbitrary function.

This viewpoint is intentionally general and is not specific to neural network architectures. It suggests a broader class of context-dependent computational models in which rich symbolic structure is paired with simple local dynamics.

Possible Research Directions

- Context-selected linear operators for genomic and other biological sequence models.
- Sample complexity as a function of context complexity versus operator complexity.
- Appropriate choices of local operator families beyond linear mappings.
- Connections with switched systems, operator theory, and context-indexed dynamical systems.
- Interpretability arising from explicit context selection combined with simple local operators.

At present, this should be regarded as a conceptual research direction rather than a specific biological model. Nevertheless, the separation of **symbolic context complexity** from **local operator complexity** may prove useful wherever extremely large discrete state spaces coexist with relatively simple local computational mechanisms.